

## PATENT ABSTRACTS OF JAPAN

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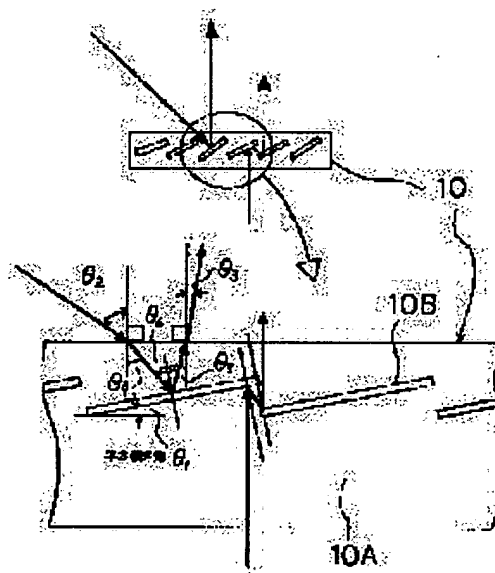
(72)Inventor : OZEKI MASAO

## (54) TRANSLUCENT REFLECTION PLATE AND DISPLAY DEVICE WITH IT

## (57)Abstract:

**PROBLEM TO BE SOLVED:** To obtain remarkably bright and excellent visibility even in a portable super small-sized and light one by making a standard deviation of tilt angles of respective planar reflection parts for a certain surface not more than a specified value and satisfying a mean tilt angle with a specified relation.

**SOLUTION:** Plural planar reflection parts 10B are provided in a transparent body 10A of a refractive index (n) so that the tilt angles of plural planar reflection parts are random as a whole. Light from a light source arranged on a rear surface side is emitted to a surface side through among plural planar reflection parts 10B. Further, the light being made incident from the surface side on a translucent reflection plate is abutted on the planar reflection parts 10B to be reflected, and is returned to the surface side, and is made incident on a display element to become display light. The planar reflection parts 10B are non-parallel as a whole, and are set so that the value of the standard deviation showing the dispersion of the tilt angles becomes  $\leq 20^\circ$  C, and the mean tilt angle  $\theta_1$  of the planar reflection parts 10B is satisfied with the relation:  $0.5 \cdot (\sin^{-1}(0.866/n) - \sin^{-1}(-0.174/n)) \geq \theta_1 \geq 0.5 \cdot (\sin^{-1}(0.342/n) - \sin^{-1}(0.174/n))$ .



## LEGAL STATUS

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 CLAIMS
 

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[Claim(s)]

[Claim 1] Two or more plate-like reflective sections are arranged, the plate-like reflective section is arranged in the transparent body of a refractive index  $n$  in the transfective reflecting plate to which light passes through between the adjoining plate-like reflective sections, and the standard deviation of the angle of inclination of each plate-like reflective section to a certain field is 20 degrees or less, and it is the average angle of inclination  $\theta_1$ . Transfective reflecting plate characterized by filling several 1.

[Equation 1]

$0.5$  and  $\{\sin^{-1}(0.866/n) - \sin^{-1}(-0.174/n)\} \geq \theta_1 \geq 0.5 - \{\sin^{-1}(0.342/n) - \sin^{-1}(0.174/n)\}$  [Claim 2] The transfective reflecting plate according to claim 1 characterized by making standard deviation of an angle of inclination into 5-10 degrees.

[Claim 3] The transfective reflecting plate according to claim 1 or 2 characterized by the average of the length of the field of the plate-like reflective section being 40 micrometers or less.

[Claim 4] It is the display characterized by having the function in which a display device changes transparency and absorption of light in the display equipped with the transfective reflecting plate and the display device, and equipping the rear-face side of a display device with a transfective reflecting plate according to claim 1, 2, or 3 and a back light.

[Claim 5] Display according to claim 4 characterized by having arranged the diffusion board between a display device and a transfective reflecting plate.

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## DETAILED DESCRIPTION

## [Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] this invention relates to the transfective reflecting plate used for display, and the display equipped with it. It is related with the display equipped with the transfective reflection type light source section which can use both the so-called back lights and so-called outdoor daylight as the light source.

[0002]

[Description of the Prior Art] The conventional transfective reflecting plate formed the transparency section between two or more reflective sections and the reflective section, and had realized semipermeability of light. This conventional example is shown in drawing 11. It was the thing of the structure by which the laminating was carried out so that much plate 10D with the very small reflector might lie one upon another in the transparent body.

[0003] When this transfective reflecting plate was used in reflective mode, the amount of reflected lights was not enough, and there was a fault that a display was dark. Moreover, when the back light was put on the background of a transfective reflecting plate and it was used by the transparent mode, there was a problem that there was very little light which passes and carries out outgoing radiation of the transfective reflecting plate.

[0004] Moreover, in this conventional example, the high permeability of light was attained by decreasing the density of plate 10D. Although the amount of transparency of light becomes high with such structure, it means that the reflected light decreases simultaneously. That is, sufficient reflected light intensity could be obtained and the opposite property of having semipermeability was not able to be reconciled.

[0005] Moreover, inclination structure was prepared in the reflector of a reflecting plate at JP,8-271884,A (example 1 of reference), and the liquid crystal display which made the use efficiency of light improve was shown. And it is the range of the angle which is not the mirror reflection direction of outdoor daylight, and it was shown in the screen side of this example of reference that it is possible to see a display. The typical cross section is shown in drawing 6. It was the display 12 with which the reflecting plate 9 which has the continuous trigonum-like reflector, and the display device 11 were put together.

[0006]

[Problem(s) to be Solved by the Invention] In the above-mentioned conventional example and the above-mentioned example of reference, the light source section which supplies the practical quantity of light to a display device was not realized. That is, the structure of the section of the light source with an efficient transfective reflex function was not indicated. When in other words using outdoor daylight positively and using a back light actively, also in any in the case of using together both outdoor daylight and a back light, visibility was good and it was brightly difficult for contrast to also obtain a high display image.

[0007] In this invention, in the reflective mode in which outdoor daylight is used, it is brighter than the conventional transfective reflecting plate, and aims at the display which can be used as the transparent mode in the display which can see a display, and dark environment using the light source light of a back light at an angle different moreover from the mirror reflection direction in the front face of display.

[0008] And even if it is micro and is lightweight, it is very bright, and it is the thing suitable for portability which is going to obtain the good display of visibility.

[0009]

[Means for Solving the Problem] That is, two or more plate-like reflective sections are arranged, the plate-like reflective section is arranged in the transparent body of a refractive index  $n$  in the transfective reflecting plate to which light passes through between the adjoining plate-like reflective sections, and the standard deviation of the angle of inclination of each plate-like reflective section to a certain field is 20 degrees or less, and a claim 1 is the average angle of inclination  $\theta_1$ . The transfective reflecting plate characterized by filling several 2 is offered.

[0010]

[Equation 2]

$0.5$  and  $\{\sin^{-1}(0.866/n) - \sin^{-1}(-0.174/n)\} \geq \theta_1 \geq 0.5$ ,  $\{\sin^{-1}(0.342/n) - \sin^{-1}(0.174/n)\}$  [0011] Moreover, a claim 2 offers the transfective reflecting plate according to claim 1 characterized by making standard deviation of an angle of inclination into 5-10 degrees.

[0012] Moreover, a claim 3 offers the transfective reflecting plate according to claim 1 or 2 characterized by the average of the length of the field of the plate-like reflective section being 40 micrometers or less. Here, length is the length in the direction of a cross section which appeared in the drawing mentioned later, and points out the portion which acts on reflection of outdoor daylight substantially. Or it is equivalent to a length of one side of the discontinuous structure of appearing in a cross section. Preferably, you may be 30 micrometers. Moreover, as for the gap of the two adjoining plane reflective sections, it is desirable to have seen from the front face about, and for it to have been referred to as several micrometers or less, or to have lapped completely.

[0013] Moreover, in the display equipped with the transfective reflecting plate and the display device, a display device has the function which changes transparency and absorption of light, and a claim 4 offers the display characterized by equipping the rear-face side of a display device with a transfective reflecting plate according to claim 1, 2, or 3 and a back light.

[0014] Moreover, a claim 5 offers the display according to claim 4 characterized by having arranged the diffusion board between a display device and a transfective reflecting plate.

[0015] Moreover, in each above-mentioned display, when a TN liquid crystal display device or a STN type liquid crystal display element is used especially, even if small, since the good display of contrast is obtained by the low power, it is brightly desirable [ it is desirable to use the liquid crystal display element equipped with the polarizing plate, and ].

[0016] Moreover, in the above-mentioned transfective reflecting plate, it is desirable that the field of the plane reflective section is aluminum or silver. It is because the reflection factor of light is raised and the whole efficiency for light utilization is raised. Moreover, since forming irregularity in the reflecting surface of the plane reflective section can obtain diffusibility simultaneously, it is still more desirable.

[0017]

[Embodiments of the Invention] Below, the composition of this invention is explained, referring to drawing 1.

Drawing 1 is explanatory drawing having shown the transfective reflecting plate 10 of this invention typically. Into transparent-body 10A of a refractive index  $n$ , as a whole, the angle of inclination of two or more plane reflective section 10B is prepared so that at random. It passes along between two or more plane reflective section 10B, and outgoing radiation of the light of the light source arranged at the rear-face side is carried out to a front-face side.

[0018] Moreover, in the plane reflective section, it is reflected, the light which has carried out incidence to the transfective reflecting plate from the front-face side returns to a front-face side, and incidence is carried out to a display device (omitted in drawing 1), and it turns into display light.

[0019] Plane reflective section 10B is not parallel as a whole, and it is made for the value of the standard deviation which shows dispersion in an angle of inclination to become 20 degrees or less. And average angle of inclination  $\theta_1$  of plate-like reflective section 10B It sets up so that a predetermined relation may be filled. At this time, the relation of a-three number is materialized from law of refraction.

[0020]

[Equation 3]  $\sin \theta_2 = n \sin \theta_4$   $\sin \theta_3 = n \sin \theta_5$  [0021] Moreover, as shown in drawing 1, several 4 relation is materialized.

[0022]

[Equation 4]  $\theta_4 = \theta_6 + \theta_6 - \theta_5$   $\theta_1 = \theta_6 - \theta_5$  [0023] Above several 4 to several 3 and  $\theta_1$  If it asks, the following several 5 will be materialized.

[0024]

[Equation 5]  $\theta_1 = 0.5$ ,  $\{\sin^{-1}[(\sin \theta_2)/n] - \sin^{-1}[(\sin \theta_3)/n]\}$  [0025] Generally, when seeing display, it is the desirable angle of visibility  $\theta_3$ . The range is  $\sim 10$  degrees. On the other hand, incident angle  $\theta_2$  of the outdoor daylight which can be used as a light source light It is 20-60 degrees. Therefore,  $\theta_1$  If the range is searched for, it will become like several 6.

[0026]

[Equation 6]

$0.5$  and  $\{\sin^{-1}(0.866/n) - \sin^{-1}(-0.174/n)\} \geq \theta_1 \geq 0.5$ ,  $\{\sin^{-1}(0.342/n) - \sin^{-1}(0.174/n)\}$  [0027] For example, when the refractive index  $n$  of transparent-body 10A is 1.5, it becomes  $21.0 \text{ degree} \geq \theta_1 \geq 3.3 \text{ degree}$ . Average angle of inclination  $\theta_1$  of a refractive index  $n$  and a plate-like reflecting plate A detailed relation is shown in drawing 3.

Moreover, the parameter and data are shown in Table 1. Furthermore, as desirable conditions, it is an angle of visibility  $\theta_3$ . It is the range of  $\theta_1$  10 degrees, and is the degree  $\theta_2$  of incident angle of outdoor daylight. It is 20-40 degrees.  $\theta_1$  The range becomes like several 7.

[0028]

[Table 1]

$\theta_2$	60	20
$\theta_3$	-10	10
屈折率 n	$\theta_1$ の上限	$\theta_1$ の下限
1	35	5
1.1	30.508	4.516
1.2	27.257	4.119
1.3	24.724	3.788
1.4	22.669	3.507
1.5	20.958	3.266
1.6	19.500	3.0581
1.7	18.244	2.871
1.8	17.147	2.708
1.9	16.180	2.563
2	15.319	2.432
2.1	14.549	2.315
2.2	13.854	2.208
2.3	13.224	2.110
2.4	12.650	2.021
2.5	12.125	1.940
2.6	11.642	1.864
2.7	11.197	1.794
2.8	10.788	1.730
2.9	10.404	1.670
3	10.048	1.614
3.1	9.716	1.561
3.2	9.406	1.512
3.3	9.115	1.466
3.4	8.842	1.422
3.5	8.584	1.382
3.6	8.342	1.343
3.7	8.113	1.306
3.8	7.896	1.272
3.9	7.690	1.239
4	7.496	1.208

[0029]

[Equation 7]

0.5 and  $\{\sin^{-1}(0.643/n) - \sin^{-1}(-0.174/n)\} \geq \theta_1 \geq 0.5$ ,  $\{\sin^{-1}(0.342/n) - \sin^{-1}(0.174/n)\}$  [0030] Moreover, when the refractive index  $n$  of transparent-body 10A is 1.5, considering as 16.0 degree  $\geq \theta_1 \geq 3.3$  degree is still more desirable. Moreover, if the front face of plane reflective section 10B is in the mirror-plane state, the angle in which outdoor daylight is reflected will be limited to the narrow range. In order to avoid this, it has a certain diffusion function, and it is bad if there is nothing.

[0031] For example, the technique (drawing 5) of arranging bead 10C which has a different refractive index ( $\neq n$ ) in the transparent body of the technique (drawing 4) of forming the front face of plate-like reflective section 10B' in irregularity and a refractive index  $n$ , the technique of arranging a transfective reflecting plate and the diffusion board which has diffusibility between displays, the technique (drawing 7) of arranging the diffusion board 7 on the top substrate of a display device, etc. can be considered. A desired effect is acquired even if it uses which technique.

[0032] In this invention, what has absorption or the function scattered about or penetrated as a display device used combining a transfective reflecting plate for the passing light is used. For example, the dielectric constant anisotropy which contained the optically active substance between two substrates which have a transparent electrode and an orientation film, respectively and were mostly prepared in parallel is the liquid crystal display element which the positive nematic liquid crystal was pinched, and the outside of a liquid crystal layer was equipped with the polarizing plate of a couple, and was equipped with the drive circuit which impresses driver voltage between transparent electrodes.

[0033] You may use the liquid crystal / macromolecule complex element by which the display device and macromolecule phase containing dichroic coloring matter, and the liquid crystal phase were distributed and formed in the liquid crystal layer. Moreover,  $\Delta n \cdot d$  of a liquid crystal layer may use the birefringence electrochromatic display device (see JP,8-292434,A) which does not use the light filter as which 1.2-2.5 micrometers and the retardation value of a birefringent plate were also chosen from 1.2-2.5 micrometers.

[0034] The manufacture method of a transfective reflecting plate is illustrated to drawing 9. The transparent body which has the configuration which carried out irregularity in the shape of a trigonum by the transparent material is created (the upper case a of drawing 9). Then, a reflecting layer is prepared only in the slant face of the structure of (a). As a reflecting layer, they are aluminum, silver, or  $\text{TiO}_2$ . The mica (mica) which carried out surface treatment by the thin film can be used. Vacuum evaporation etc. performs formation of a reflecting layer and the structure where the coat of the reflecting layer was carried out on the shape of toothing is acquired (the middle b of drawing 9).

[0035] Under the present circumstances, you may give a mask to the unnecessary part of vacuum evaporation. When forming the transfective reflecting plate of big size, you may stick and form a reflective film. Furthermore, a transparent material (refractive index  $n$ ) is slushed on this. And the structure which consists of transparent-body 10A and plane reflective section 10B is formed (the lower berth c of drawing 9). The slushed transparent material may serve as adhesion material at this time.

[0036] The another manufacture method is shown in drawing 10. Reflecting layer 10b is formed on transparent-body 10A. The formation method of reflecting layer 10b is formed by applying what carried out the vacuum evaporation of aluminum or the silver, or distributed the minute plate-like reflecting plate in transparent-body material.

[0037] Furthermore, a stratum lucidum is prepared on it, a reflecting layer is repeated further by turns, a laminating is carried out one by one, and multilayer structure is established. By cutting this in a configuration like rectangle 10x aslant illustrated on space (dashed line), the transfective reflecting plate 10 of this invention can be manufactured.

[0038] Under the present circumstances, the inclination of the plane reflective section can be made random by preparing each class so that thickness may change from one edge to a wedge shape to the other end. What is necessary is to prepare the thickness of a stratum lucidum in inclination, or just to form thickness change by etching.

[0039] As a method of driving the display device included in the display of this invention, a multiplexer drive may be used and the active drive by active elements, such as TFT and MIM, may be used. Moreover, the back light of the light source section should just use the thing which used EL, or the thing using Light Emitting Diode and the light guide plate also by the side light type which used the cold cathode tube and the light guide plate.

[0040] As a display device, the display device equipped with the light filter for colorization is sufficient. In this case, although there is a problem to which a display becomes dark in a reflective display when a light filter is generally used for a display device, a bright display will be attained if this invention is used.

[0041]

[Example]

(Example 1) Drawing 2 is the typical cross section of the display using the transfective reflecting plate 10 of the example of the book of this invention. It is the display with which top polarizing plate 1A, the phase contrast board 2, top substrate 3A, top electrode 5A, top orientation film 4A, the liquid crystal layer 6, bottom orientation film 4B, bottom electrode 5B, bottom substrate 3B, bottom polarizing plate 1B (it is above and a display device 11 is constituted) and the diffusion board 7, the transfective reflecting plate 10, and the back light 8 were formed from the screen side.

[0042] The transfective reflecting plate 10 was created by the method shown in drawing 9. The shape of a triangle was continuously established by the transparent material (refractive-index  $n=1.59$ : polycarbonate), and the front face was irregularity-ized (upper case a). Average angle of inclination  $\theta_1$  of each plane reflective section to the front face of a transfective reflecting plate It was set as about 10 degrees.

[0043] Moreover, the standard deviation of an angle of inclination was set as about 0 degree. Then, except the slant face of the structure shown in (an upper case a), the mask was carried out and the reflecting layer of aluminum was formed by vacuum evaporation (middle b). Besides the transparent material (refractive-index  $n=1.59$ : polycarbonate) was slushed, and the structure of the transfective reflecting plate made into the purpose was formed (lower berth c).

[0044] In this example, in order to raise the diffusibility of light between the transfective reflecting plate 10 and a display device 11, the diffusion board 7 was formed. Moreover, the field-like emitter of the side light back light method which combined the cold cathode tube and the light guide plate was used for the back light 8.

[0045] In the liquid crystal layer 6, 240-degree twist and  $\Delta n \cdot d$  set  $\Delta n \cdot d$  of 0.85 micrometers and the phase contrast board 2 to 575nm. The drive performed 1 / 240 duty drives using the time-sharing driving method.

[0046] It incorporated and used for the pocket formula personal computer as shows the display of this example to drawing 8. This pocket formula personal computer inputs by keyboard 20C, and display section 20A is used in the

state of a fixed inclination to this soma 20B (it sets to drawing 8 and is about 120 degrees). And in case it is used, the light of the back light built in display section 20A, using the light from outdoor daylight 100, such as the sun and indoor lighting, is used.

[0047] Average angle of inclination  $\theta_1$  of a transfective reflecting plate Since the refractive index of the transparent body was 1.59 at about 10 degrees, it became the brightest to the incidence of the light which inclined about 30 degrees of perpendicular shells to the field of transfective reflection type display. Since the reflect lump of outdoor daylight 100 was reflected regularly and progressed to the bottom at this time, the fall of the contrast of a display did not occur but the legible display was obtained for the user 15. Moreover, the outdoors of night etc. became possible [ checking a display by looking ] by making a back light turn on under the environment where outdoor daylight cannot be used.

[0048] (Example 2) It was made the same composition as an example 1, and the transfective reflecting plate was created by the option. On transparent-body 10A, as reflecting layer 10b is shown, it is formed at drawing 10. It is the thing of structure which embedded plate-like reflecting layer 10b which consists of a minute piece of aluminum into transparent-body 10A.

[0049] In this example, one reflecting layer 10b is formed by applying the transparent material containing the above-mentioned minute piece on transparent-body 10A. Furthermore, it repeated successively preparing a stratum lucidum on it and preparing a reflecting layer further, and multilayer structure was acquired.

[0050] The transfective reflecting plate was manufactured by cutting this, as shown in rectangle 10x of drawing 10. Since the plane reflective section itself had concavo-convex structure substantially, even if a diffusion board was not separately used for this transfective reflecting plate outside, its range of the reflective direction of the light source was not too narrow. Since the diffusion board which was almost the same as the example 1 as an effect was not used, manufacture is easy and productivity improved.

[0051] (Example 3) The back light was set to EL with the same composition as an example 2. Since EL back light was light and thin, it was able to obtain the display suitable for the cellular phone.

[0052] (Example 4) With the same composition as an example 2,  $\Delta n \cdot d$  of 1.27 micrometers and a phase contrast board was set to 1.40 micrometers for  $\Delta n \cdot d$  of a liquid crystal layer.  $\Delta n = 0.196$  (at the time of 25 degrees C) of the liquid crystal to be used and TC set 99 degrees C and the dielectric constant anisotropy to 15 (at the time of 25 degrees C), and viscosity 24cSt (at the time of 20 degrees C). The glass substrate used 0.4mm \*\*. 4 gradation displays were performed by 1/65 duty.

[0053] Each gradation is 0%, 41%, 65%, and 100%. Each gradation corresponds to white, an orange, blue, and green coloring, respectively. The color display (solvent refined coal) using the birefringence became possible.

[0054] (Example 5) With the same composition as an example 1, the standard deviation of an angle of inclination was set as 7 degrees. Thereby, since the transfective reflecting plate itself had a diffusibility function, it becomes unnecessary to have prepared the external element which raises the diffusibility of light, and the diffusion board 7 was able to be omitted. Therefore, -izing of the display was able to be carried out [ thin shape ] more.

[0055]

[Effect of the Invention] The liquid crystal display element of this invention can be used as a functional element which bears display functions, such as various kinds of noncommercial dot-matrix display (audio equipment, a clock, a game machine machine, an amusement, communication equipment, car navigation, a camera, TV telephone, display of a calculator), such as an operation display of a personal computer, a word processor, a fish detector, the in stool face panel for mount, an information terminal, an industrial information-display device (for example, control panel of a copy machine), or a power device.

[0056] Since especially the transfective reflection type display of this invention can be used by the low power, when it uses for portable electronic equipment, for example, a cellular phone, an electronic notebook, an Electronic Book, an electronic dictionary, PDA (Personal Digital Assistant), a pager (pocket bell), etc. especially, it demonstrates high functionality together with the high visibility and power of expression. Moreover, also in dark environment, it can check by looking brightly.

[0057] Moreover, in invention of a claim 2, an external diffusion board is made unnecessary and the structure of the whole display can be simplified.

[0058] In invention of a claim 3, the homogeneity of light source light can be raised and the few display of a feeling of a rough deposit can be attained.

[0059] Moreover, the high display of display grace can be attained in invention of a claim 4. Furthermore, this invention can perform application various in the range which does not lose the effect.

[Translation done.]



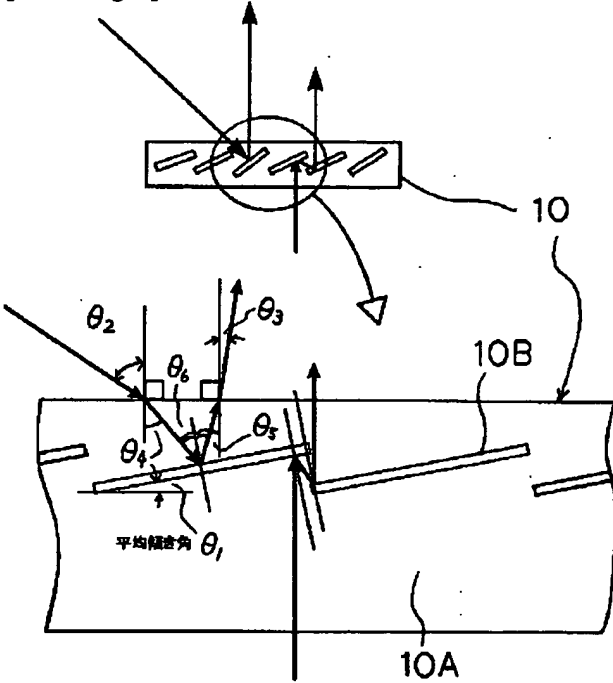
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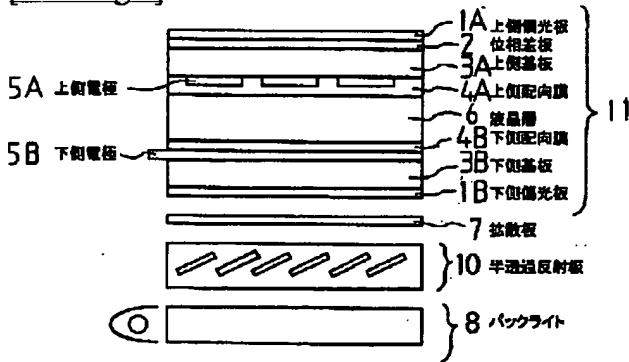
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DRAWINGS

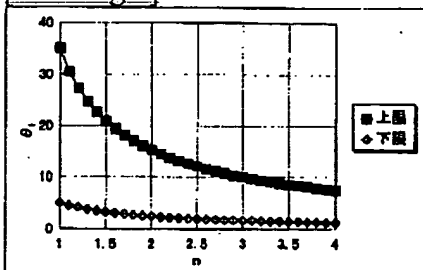
[Drawing 1]



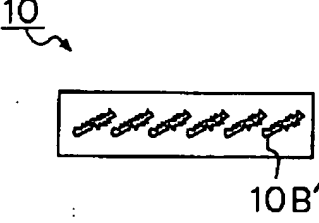
[Drawing 2]



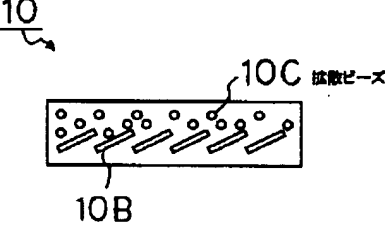
[Drawing 3]



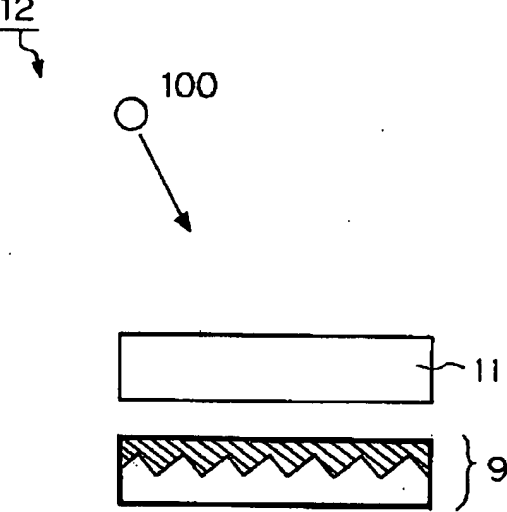
[Drawing 4]



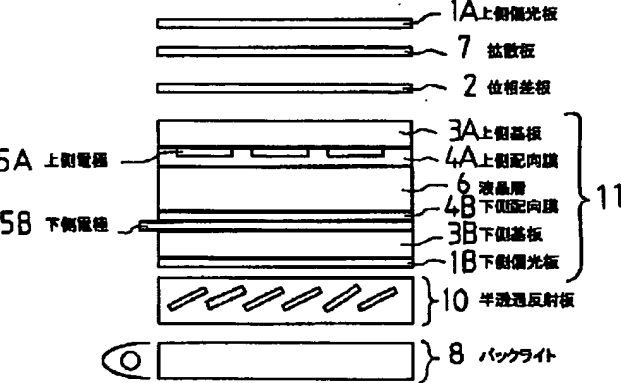
[Drawing 5]



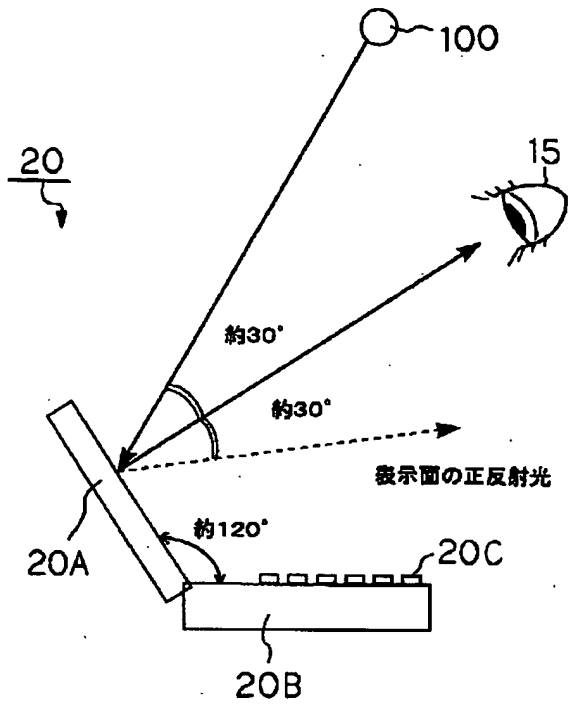
[Drawing 6]



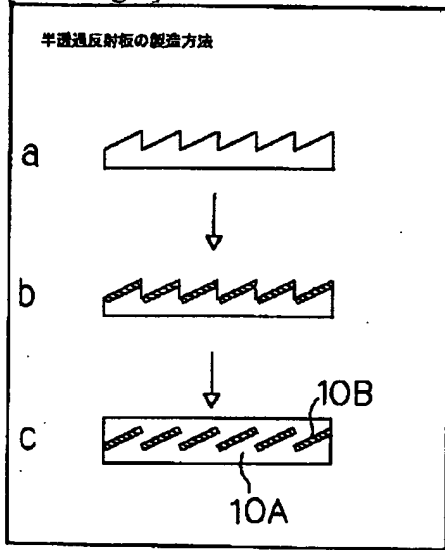
[Drawing 7]



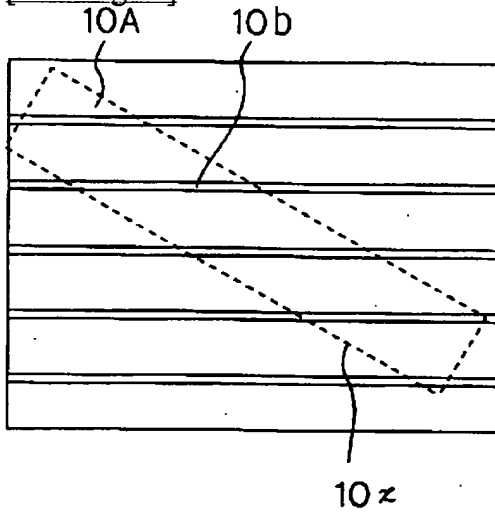
[Drawing 8]



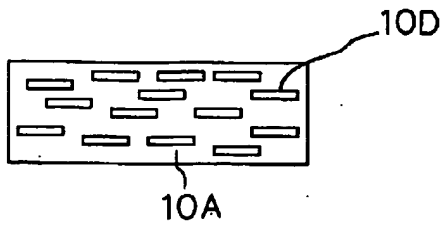
[Drawing 9]



[Drawing 10]



[Drawing 11]



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